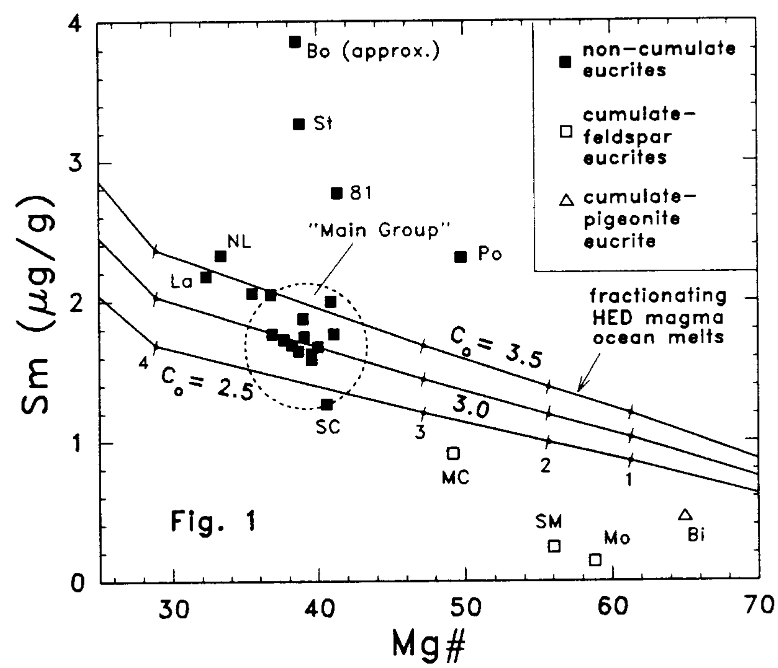
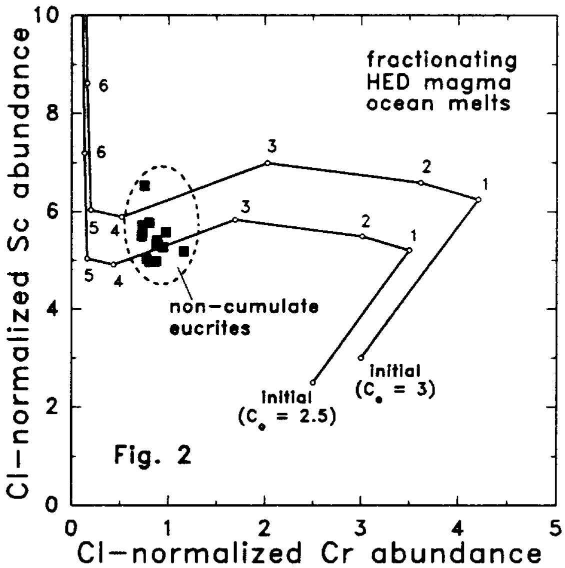
COULD EUCRITES HAVE FORMED AS RESIDUAL LIQUIDS IN A MAGMA OCEAN? Alex Ruzicka, Gregory A. Snyder, and Lawrence A. Taylor. Planetary Geosciences Institute, Dept. Geological Sciences, University of Tennessee, Knoxville, TN, 37996.

Two hypotheses for the origins of non-cumulate eucrites have long been debated. These are that eucrites: (a) formed as primary melts of the eucrite parent body, produced by relatively low-degrees (4-30%) of equilibrium (batch) partial melting [1-3]; or (b) formed as residual melts in a magma undergoing fractional crystallization, possibly in the same magmatic system that earlier had crystallized diogenites [4, 5]. In a companion abstract [6], we suggest that eucrites and diogenites could have formed out of the same, evolving magmatic system, a "magma ocean" on the howardite-eucrite-diogenite (HED) parent body. In this abstract, we examine more closely the idea that eucrites could represent residual liquids in such a magma ocean, based on data for major elements (exemplified by Mg# = Mg/(Mg+Fe)), highly incompatible trace elements (exemplified by Sm), and moderately incompatible/ compatible elements (exemplified by Sc and Cr). We conclude that the compositions of most, but not all, eucrites are consistent with their having formed as residual liquids in a magma ocean.

Mg# and Sm: Warren and Jerde [5] used an Mg#-Sm diagram similar to that of Fig. 1 to argue that most non-cumulate eucrites represent residual liquids. In Fig. 1 (eucrite data: [5]), we show melt-composition trajectories produced by fractional crystallization of a melt that has an initial major-element composition identical to that of the silicate portion of the HED parent body as determined by Dreibus and Wänke [7]. The MAGFOX program, developed by J. Longhi, was used to determine the proportions of crystallizing phases and the Mg# of residual melt compositions (initial Mg# = 79). Output from MAGFOX was used together with partition coefficients for Sm [8] to determine the Sm content of the residual melts. Curves are shown for three values of initial, normalized Sm content (C_o) corresponding to 2.5, 3.0, and 3.5 x CI abundances. Numbers associated with ticks on the curves correspond to melt compositions at various stages of magma ocean solidification: 1 = 56%, 2 = 62%, 3 = 69%, and 4 = 78% solidification. Of the non-cumulate eucrites plotted in Fig. 1, all but four (Bouvante, Stannern, ALHA 81001, Pomozdino) lie on or near the calculated fractionation trends, between melt compositions 3 and 4, assuming C_o ~2.5-3.5. C_o ~3 gives a good match to most non-cumulate eucrites. *The data for Mg# and Sm suggest that most non-cumulate eucrites can be regarded as residual melts of a crystallizing magma ocean on the HED parent body, enriched in Sm by ~3 x CI chondrites.* Cumulate eucrites fall off the calculated trends (Fig. 1), as might be expected, as cumulates do not directly represent melt compositions.

Cr and Sc: Jurewicz et al. [3] and Jones et al. [9] suggested that the abundances of Cr and Sc (and V) in eucrites may be key to understanding the petrogenesis of these meteorites. Fig. 2 (eucrite data: [5, 13, 14, 15]) shows melt-composition trajectories for Sc and Cr produced by fractional crystallization of the HED magma ocean, using the same method as described above. Trajectories are shown for two values of C_o (2.5 and 3.5 x CI chondrites). The partition coefficients, D_{Sc} and D_{Cr}, for olivine and pyroxene decrease with an increase in temperature [10-12], and an attempt was made to use values of D_{Sc} and D_{Cr} corresponding to the appropriate temperature. Sc appears to change from a weakly incompatible element during olivine and orthopyroxene crystallization [11], to a weakly compatible element during pigeonite crystallization [11], and Cr appears to change from a weakly incompatible element during olivine crystallization





[16], to an increasingly compatible element as pyroxene crystallizes at progressively lower temperatures [17]. This change in compatibility behavior accounts for the complicated melt composition trajectories shown in Fig. 2. The calculated trajectories intersect eucrite compositions between melt compositions 3 and 4, the same as inferred based on Mg# and Sm. The trajectory for C_o = 2.5 appears to provide the best match to eucrites, but the calculations are uncertain because: (1) Sc and Cr may not be present in the same initial chondrite-normalized abundances, as Sc is refractory and Cr is non-refractory, and (2) MAGFOX may overestimate the amount of chromite that crystallizes between melt compositions 2 and 3, as discussed in the companion abstract [6]. Despite these uncertainties, *the data for Sc and Cr are consistent with the hypothesis that eucrites represent residual melts produced by fractional crystallization in an HED magma ocean.*

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